Kydex Lab

SONORAN DESERT INSTITUTE

SCHOOL OF FIREARMS TECHNOLOGY

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Development and Design of Holsters

Sheathing equipment has been a part of weaponry since the very beginning of warfare. It is described in the Bible that King David used a small leather pouch to sling his stones and then drew Goliath's sword from his sheath to slay him. Since the beginning of gunpowder warfare, the tradition of holstering arms has also been in place. The Chinese Heilongjiang hand cannon, produced no later than 1288, was reported to be carried on the back of mounted infantry. In fact, most of the portable arm holsters carried by soldiers were meant for mounted cavalry. As the spread of wheel lock pistols in the 1520-30s enabled cavalry caracole, a maneuver designed to break up squares of pike men, conical leather holsters became common.

Attached to the warhorse saddle, they permitted easy drawing and reholstering even with hands clad in gauntlets. During the Ottoman Empire,

Figure 1: A conical leather holster used to house a wheel lock pistol.

Figure 2: A dual pistol kuburluk holster, ca. 17th Century.

Figure 3: A replica of a triple flintlock pirate baldric.

Figure 4: Western pommel holster replica.

other designs were used with flintlocks, such as the double-gun kuburluk sheath among other designs. In the 18th Century, pirate baldrics were slung over the shoulder and included a leather wrap to holster their flintlocks.

The most famous of pistol holsters has been ubiquitously found in the American West from the early 1800s even up to today. During this time, rifle scabbards were used in the American West, and in the 1830s pistols were first sheathed in a "pommel holster. This holster was an adaptation from the pommel bag, which housed the weapon on the side of a travel bag and draped over the saddle horn, or pommel. When the U.S. Army issued heavy revolvers, such as the Colt Army Walker, the pommel holster could drape two pistols, one on each side, or one pistol with an accompanying ammo bag.

The mid-1850s became a golden era of small arms development. The Colt Model 1851 Navy Revolver was issued to Army troops and became a mainstay on the frontier. The military-issued holster used a holster with a flap over the top and a button that snapped. This was a very slow draw design and was used to transport a sidearm during inclement weather. Townspeople during the California Gold Rush modified this design to allow for a quicker access to the firearm under duress. The top flap was discarded, and, in some cases, a cutout was made to expose the trigger. This was dubbed the "Slim Jim" holster, a long draw design attached to a belt. This design later became known as the "Mexican loop," a popular design that sheathed the eponymous Colt Single-Action Army pistol. Sewn loops were stitched in the belt to hold the cartridges; this combination of the holster

Figure 5: Replica of the flap holster used for Army holsters.

stitched with a later holster is a design known as the "Buscadero." Famous gun fighters, such as "Wild Bill" Hickock, "Curly Bill" Broccius, and others, used adaptations of this fast draw design.

When Eastern elites headed to the Old West, carrying firearms in public was deemed unsightly and outlawed in many cities. Westerners skirted around these laws by concealing their firearms on their person, and thus we started to see the

Figure 6: Modern quick-draw holster.

Figure 7: Reproduction "Mexican Loop" holster design.

Figure 8: The "Buscadero" design became the iconic holster of the Old West, and many cowboy movies featured this belt/holster combination in the 1950s.

Figure 9: An example of the Canadian WWII uniform and the Ingalls Hi-Power Stock Holster.

shoulder holster designs. A gunfighter would lop off the barrel of his trusty Colt Army Single-Action and carry a shoulder holster under his duster trench coat. Both ladies and gunfighters alike used a "heel gun" — most notably the Derringer — as a small concealed model pistol on their person.

MILITARY AND POLICE HOLSTERS

In most armies, pistols were more a badge of rank than front line weapons. They were carried much but used infrequently, so protective flap holsters were focused more on protecting the sidearm from the elements than on quick draw. The same was true of handguns issued to operators of crew-served weapons, like cannon or tanks. Such holsters were belt-mounted but held up primarily by shoulder straps. Starting with the Borchardt C-93 (1893), wooden holsters doubling as shoulder stocks remained popular

Figure 10: The WWII Russian TT33 pistol with a flap holster.

through the 1960s. Mauser C96 and later Astra copies, Browning M1905 and Colt M1911, Luger P08, John Inglis Hi-Power and the Soviet APS all used this to improve longer range accuracy until the niche got filled with small submachine guns. While the military uses pistols as a secondary weapon, the opposite is true for police agencies. Perfecting the use of pistol holsters has always been a priority of law enforcement through the ages. During the early 1900s, the police started using a British Army design called the Sam Browne Belt. This was used extensively throughout both the First World War and can even be seen today in uniforms the world over.

Figure 11: Modern police belt with holster attachments for magazines, flashlights, sidearm, and other accessories.

Police agencies quickly adopted the design not only for weapons retention but also its ability to use accessory pouches for handcuffs, radios, flashlights, and other items.

MODERN CIVILIAN HOLSTERS

The modern civilian holster is a huge leap forward in design and technology compared to holsters from even 50 years ago. While early holster designs were simply "pouches" that many differently shaped and sized pistols rested in, modern holsters are often fit to one specific pistol make and model. The difference between an early and modern holster is like the difference between a custom-tailored suit and a one-size-fits-all sweat suit. The modern holster's performance is far beyond anything early holster designs could hope to offer. The modern holster is safer and provides better retention and ergonomics, while still allowing for a fast draw under various conditions. Modern holsters are also more durable and more concealable, while inducing less wear on the pistol's finish. They can also be found in an array of designs and materials to suit any specific needs or wants.

Figure 12: Example of inside the waistband holster.

Holster Material

Thanks to advancements in modern materials, the modern holster does not suffer from issues that early holsters faced. Early leather holsters would begin to sag when exposed to sweat and other moisture, causing issues when reholstering as well as negligent discharges. Prolonged exposure to moisture would also lead to mold and mildew on leather, as well as cause rust and verdigris on the guns.

Modern holsters utilize materials that are more durable and resistant to moisture. The most common modern holster materials are leather, nylon, Kydex® and hard plastic. A holster may be constructed entirely from one type of material, or from several different materials.

However, newer leather holsters also benefit from newer technologies, such as improved fabricating techniques and advanced moisture repelling treatments. These leather holsters will utilize thick or heavy material, backing material, and stitching to increase their stiffness and prevent sagging that may interfere with holstering the pistol. Modern leather holsters also utilize different natural and synthetic finishes to seal and protect the material.

Nylon is not subject to decay from moisture like leather or other organic materials. Nylon will not rot or sag when exposed to prolonged moisture from sweat or another source. Unlike leather holsters, nylon holster fabric will not hold a shape and cannot be form fitted to a specific firearm. Nylon holsters are typically designed to be one-size-fits-most.

Kydex® is a type of thermoplastic polymer that is perfect for the do-it-yourself holster maker.

Figure 13: Leather holster for the CZ Skorpion pistol.

Figure 14: The Army issue M12 nylon holster can hold a Beretta M9 or the venerable M1911 (shown).

Figure 15: Kydex holster.

Figure 16: Injection molded holster.

Kydex material is available in various-sized sheets and colors, is easy to process, and is capable of withstanding hard use and abuse. Kydex can be easily formed with heat, will hold its shape once cooled, and can take the shape of almost any object (as we will discuss later). An added benefit is that this type of holster can be reshaped after its initial forming. This material is also impervious to moisture and will not decay when exposed to elements from everyday use.

Like Kydex, hard plastic is also a thermoset polymer but it is not viable for the average hobbyist. Hard plastics are typically injection molded and consist of pure polymer or a type of fiber reinforced polymer (FRP). Hard plastic features all the same benefits as Kydex: moisture resistance, durability, and the ability to provide a "tailored fit." But, it cannot be reshaped after the initial forming.

IWB VS. OWB

Holsters can be divided into two basic categories: w (IWB) and Outside the Waistband (OWB). Inside the waistband holsters are designed to be tucked inside of pants for concealment. Outside the waistband holsters are designed to be worn outside of pants. Almost all holsters worn outside of pants can be considered outside the waistband holsters.

The decision to use either an IWB or OWB holster is based on a few different factors, which include state and local law, the pistol, your outfit and even the weather. Some states and counties allow for "open" carry, while others allow citizens to conceal carry, both, or neither. Typically, states that allow for open carry require the pistol to be exposed (out in the open) without any type of covering (except holster), while the

Figure 17: IWB versus OWB holsters.

pistol must be fully covered when being concealed. Based on state and local law, an OWB holster would be better suited for open carry, while an IWB holster would be better suited for concealed carry.

The size of the pistol, your outfit, and the weather will also determine how you carry, an IWB or OWB. Because pistols come in many sizes, from large (full) to extra small (subcompact), the size of your pistol will determine how you carry it. It may be difficult for a smaller person to carry a full-sized pistol IWB, but it may also be impractical for that same person to try to conceal the same pistol in an OWB holster. If the same person were wearing baggy clothing or it was cold outside, and they were wearing a large coat, it may be easier and more practical to use an OWB holster.

RETENTION LEVELS

Holster retention can be classified into two categories and several different levels of retention. The two categories are passive and active retention. The three basic levels of retention are I, II and III. A passive retention holster relies only on the friction that is created by the shape and material of the holster. If the fit of the holster is tighter to the pistol, then there will be more retention than a holster that is a looser fit. There are no other means or devices used to retain the pistol in the holster. Passive holsters are also classified as Level I retention holsters.

To retain the pistol, active retention holsters utilize a second means or device beyond the friction created by the holster itself. The most common active retention devices include the thumb break, thumb loop, or "hood," and trigger guard lock. Holsters that utilize one active retention device are classified as Level II retention, while holsters that use two or three active retention devices are classified as Level III and IV, respectively.

The thumb break holster utilizes a strap and a button snap to retain the pistol. The strap fits across the back of the pistol in the holster and is fixed to the holster on one end and attaches by snap button on the other. When the operator draws the pistol, he/she must first undo the snap and move the strap before removing the pistol from the holster. When reholstering, the strap must be placed over the pistol and the snap must be closed.

Figure 18: A thumb break holster.

Figure 198: A hooded holster.

A thumb loop (or hooded) holster utilizes a piece of material (strap or loop) over the rear of the pistol, similar to the thumb break. Instead of the strap being unsnapped, the piece must be rotated forward, uncovering the pistol. When the pistol is reholstered, the loop must be rotated back over the pistol.

The trigger guard lock holster utilizes a spring-loaded mechanism that fits inside the trigger guard of the firearm. When the operator draws the pistol, he/she must depress a button or lever, which will move the lock from the trigger guard and allow the pistol to move upward, out of the holster. When the pistol is reholstered, the lock automatically catches the trigger guard and locks the pistol into the holster. Depending on design, the lock is deactivated either by the trigger finger or the thumb.

Figure 20: A military sniper utilizing the SERPA II holster, an example of the "trigger lock" design.

Holster Type	Retention Level			
	I	II	III	IV
Pancake	X			
Taco	X	X		
Hybrid	X			
Thumb Break		X		
Hooded		X		
Trigger Guard Lock		X		
Paddle	X	X	X	X
Pouch		X	X	
Shoulder	X	X		
Pocket	X			
Belly Band	X			

Figure 21: A chart depicting the various retention levels of common holsters designs.

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Types of Holsters

Outside of a holster's category, classification, or level of retention, there are many different types of holster, based on their construction. Holster types will also vary depending on their purpose. The various holster types are discussed below.

PANCAKE

The pancake holster is typically constructed of two pieces of material that are sandwiched around the pistol. The material may be leather, nylon or Kydex. This design leaves "wings" on both sides of the pistol, where it can be attached to the operator. There may be belt clips or slits in the wings depending on whether the holster is intended for IWB or OWB. When a pancake holster is used for IWB, the holster itself in tucked inside of the pants, while the belt clips rest outside of the pants on the belt. When a pancake holster is used for OWB, the belt is looped through the slits in the wings and the holster is secured to the body by the belt. Pancake holsters are typically Level I retention holsters but can also be found in Level II variants.

Figure 22: Pancake holster.

Figure 23: One-piece holster.

ONE-PIECE (TACO)

A one-piece or "taco" holster is typically constructed from a single piece of material that is folded over the pistol. One-piece holsters can be found constructed from leather, nylon, Kydex, and hard plastic. The taco design leads to a holster that is very compact and creates a very small footprint. The one-piece holster may use belt clips for IWB carry and other attachments for use as an OWB holster, and are typically Level I retention, although some Level II retention models exist (Figure 23).

PADDLE

Paddle holsters utilize a large "paddle" to anchor the pistol to the operator. The paddle rests inside the waistband while the pistol itself is carried OWB. Paddle holsters may be constructed from leather, Kydex, or hard plastic, while the paddle itself is always constructed from some type of hard plastic. The paddle design is meant to provide a larger surface area to secure the

Figure 24: Paddle holster.

Figure 25: Hybrid holster.

holster to the body and provide a more consistent draw. Paddle holsters can typically be found with Level I and II retentions.

HYBRID

A hybrid holster is a type of IWB holster that is constructed from two dissimilar materials. Typically, the part of the holster that secures the pistol is constructed from Kydex or hard plastic, while the part that rests against the body is constructed from leather or nylon. The dual material design allows the pistol to be secured by a tight Level I retention design, while providing a soft backing for the comfort of the operator. The backing material extends beyond both sides of the Kydex/plastic piece and features belt clips that secure the holster to the operator (Figure 25).

POUCH

The pouch holster is a modern take on the traditional pouch-style holster. The typical pouch design utilizes a bag or box that is covered by a flap. With some designs, the pistol rests inside the pouch and is covered by a snap button flap or magnetic flap (Level II retentions) while other models use an additional magnet inside of the pouch to help secure the pistol (Level III). The pouch-style holster can be found in both IWB and OWB models, with the latter resembling large phone cases. While the draw of the OWB models is fairly like that of a traditional holster with the removing of the flap and upward draw of the pistol,the IWB models use a slightly different technique. With IWB models the cover flap is typically pulled upward,

Figure 26: Pouch-style holster.

bringing the pouch and pistol up and out of the pants and exposing the pistol to be drawn. The OWB pouch holster allows the pistol to be concealed in plain sight.

SHOULDER

The shoulder holster is a type of OWB holster that is worn under the armpit of the operator. The holster itself may be constructed from leather, Kydex, or hard plastic, while the holster's straps may be made from leather or nylon. The holster positions the pistol so that the muzzle faces the back of the operator and is canted slightly downward. The shoulder holster typically uses a thumb break to secure the pistol but may also be found with Level I retention. The holster design requires the pistol to be drawn "cross body," meaning the operator must reach across his/her chest and draw the pistol across the front of the body. The shoulder holster is typically designed for concealed carry but can only be concealed when wearing an overshirt or jacket.

Figure 27: Shoulder holster.

Figure 28: Example of a drop leg holster design.

DROP LEG

The drop leg holster is a type of holster that is worn on the thigh. While most traditional holsters are worn on a belt along the hip, the drop leg holster is secured to the thigh via multiple straps. The holster itself is typically constructed from leather, Kydex, or hard plastic, and the straps may be made from nylon or leather. The drop leg holster is always designed for OWB carry and is never concealable (except with large, long jackets). The drop leg design places the pistol in a more ergonomic place (near the hand on an extended arm) and provides a more natural draw.

POCKET

The pocket holster is designed to protect the trigger of the pistol while it is stored in the pocket (Figure 29). The pocket holster is designed to work with subcompact and micro pistols. Typically, the pocket holster is designed to be removed from the pocket before drawing the pistol from the exposed holster, while other designs allow the pistol to be drawn from the pocket while the holster remains. Some models of pocket holsters feature a cutout that allows the pistol to be fired without removing it from the holster. The pocket holster is typically

Figure 29: Pocket holster.

constructed from leather or nylon, but Kydex and hard plastic models exist.

BELLY BAND

The belly band holster is not like a traditional holster. The belly band is more like a large belt or other garment that is worn on the upper body. A pocket on the band stores the pistol while a t-shirt or other garment is used to conceal it. Belly band holsters are almost always found with Level I retention. When drawn, the operator must clear the cover garment and simply lift the pistol from the pouch. The holster itself can be formed with various materials, but the actual band itself is made of elastic material.

Figure 30: Belly band.

Thermoforming

Ever since the creation of knives, swords, and handguns, a type of sheath or holster was made. It was not until the creation of plastic in the early 1900s that thermoforming was used. Thermoforming is a process wherein a final shape is given to a material, such as plastic, with the aid of heat and usually pressure.

Thermoforming is a method that manufacturers use to produce everyday products by heating plastic sheets to a pliable form and molding them to a specific shape. Vacuum thermoforming is the process of forming plastic by the use of a vacuum to create the pressure needed to form around a mold. Vacuum thermoforming is used on products such as interior car door panels, bathtubs, and food containers.

The development of modern machinery for the thermoforming industry took place between 1930 and 1950. Before World War II, E. L. Helwig of Rohm and Haas Company in Philadelphia, an acrylic resin manufacturer, put a great deal of development effort into forming airplane acrylic canopies that were free of flaws. With this effort, they created two patents using different techniques, which, after some improvements, are still being used today.

THERMOFORMING KIT

Your thermoforming kit includes the following:

- (1) 12 in. x 12 in. piece of .080 Kydex material
- (1) J-hook mounting attachment with screw assemblies
- (2) IWB loops with screw assemblies
- (12) #8-9 black fastening eyelets
- (2) .500 Chicago Screw assemblies

Figure 31: Kit contents.

Figure 32: Eyelet setting tools.

- (2) .500 rubber spacers
- (1) Hand setter kit – this #8 (¼ in.) hand flaring set comes with (1) base and (1) flaring tool (Figure 32)
- (2) Sheath/Holster making foam (8 in. x 12 in. x 1 in.) (Figure 33)

Recommended list of additional items:

- Polish compound
- Sandpaper of various grit
- Eyelet and snap setting system (Figure 34)
- Heat gun
- Infrared thermometer (Figure 35)

Figure 33: Holster making foam.

Figure 35: Two different types of infrared thermometers.

Figure 34: Two different types of eyelet and snap setting tools. Top: CKK rivet/eyelet flaring dies with guide, Journeyman Series. Bottom: Arbor Press with CKK rivet/eyelet flaring dies with guide, Master Series.

EQUIPMENT

It is very important to have the proper tools required to start your forming process. Listed below are the basic tools needed to make a knife sheath or gun holster.

- MATERIALS
  - **Thermoform sheet** – Have plenty to cover the firearm or knife of your choice. Sheets come in many different colors and textures, including printed designs.
  - **Tape** – Painter's tape or any non-textured, minimally sticky tape will do (e.g. 3M™ or FrogTape®).You do not want to have to clean the adhesive off of the object that you are molding.
  - **Molds** – This is what you want to form (Figure 37). It can be a knife, gun, or actual size gun replica (i.e. BLUEGUNS®, molding drones). There are a few companies that make replica guns for holster making. Beware that some gun replicas that are

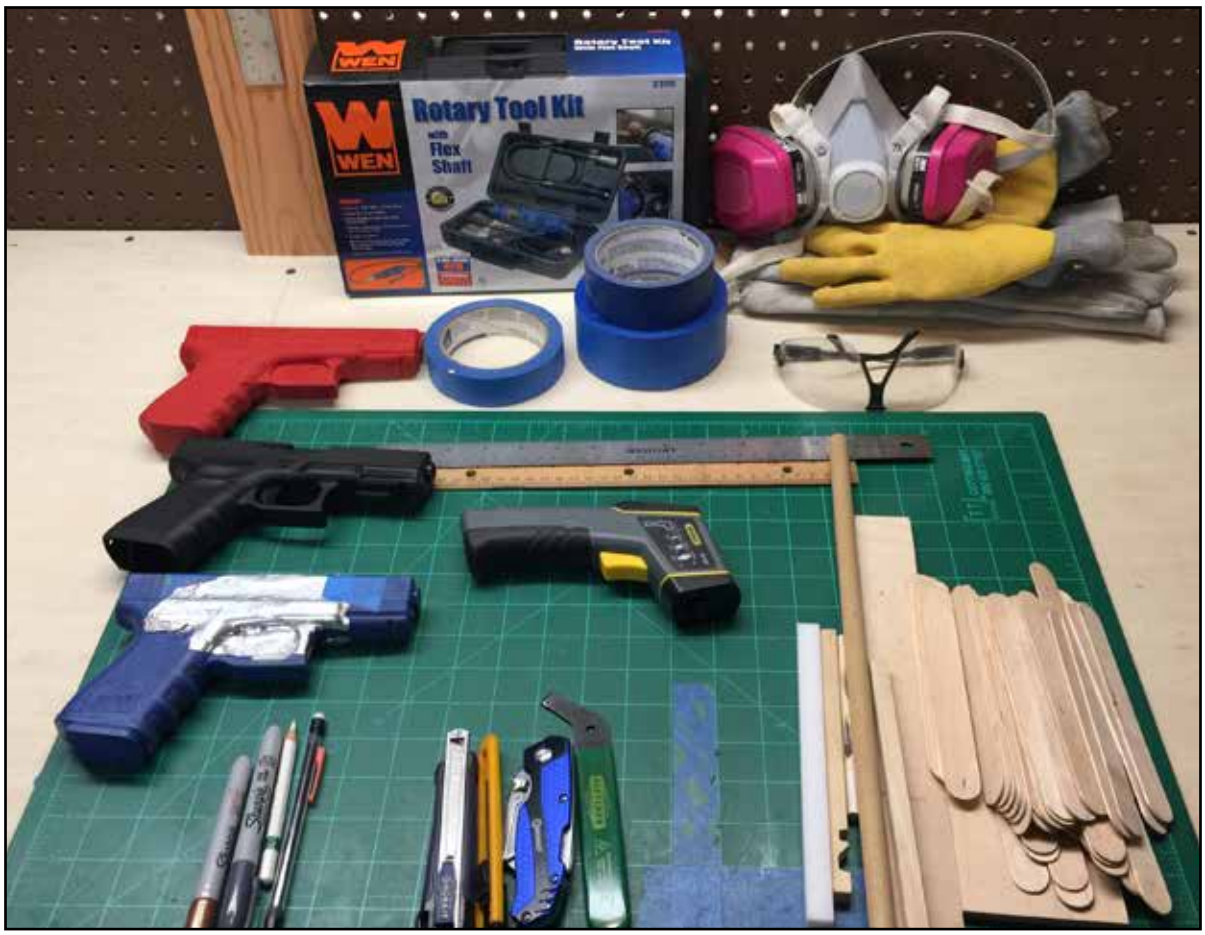


Figure 36: Picture of some of the equipment that will be used during the thermoforming process.

Starting from the bottom left: Markers and pencils , different types of cutting tools, wood for blocking. Second row: Different firearm molds to include the actual pistol, ruler, infrared thermometer. Top row: Rotary tool kit, painters tape, face mask, gloves and safety glasses.

for other purposes are not made with the same dimensions as the actual gun.

- **Blocking** – Blocking is used to relieve indentions or objects that may keep the gun from being removed from the holster (Figure 38). Types of blocking can be wood, dowel rods, paint stirrers, craft sticks or pencils. It can also be plastic, like HDPE (high-density polyethylene).
- **Attachments** – Belt attachments and fasteners will be needed.

Figure 37: Different types of molds that can be used. Top Left: Holster making mold. Top Right: Ring's BLUEGUN training firearm. Bottom: Actual firearm.

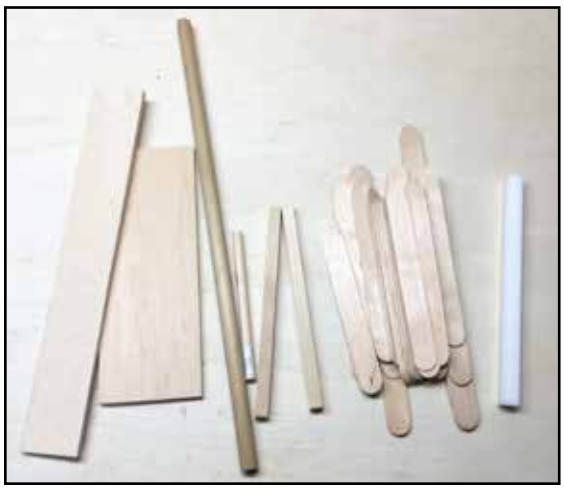


Figure 38: Different types of items that could be used for blocking.

- Belt attachments can be made of leather, metal, or rubber/silicone, and can be injection-molded or even be belt attachments that you make yourself with the same material that you use for the holster.
- Fasteners will consist of screws, binding posts, or eyelets.

Figure 39: Cutting tools.

- **TOOLS**
  - **Cutting** – Cutting tools will be needed to cut the blocking materials and plastic sheet (Figure 39). Start with a razor blade. This can be used to cut various materials. A rotary tool with cutting wheel can be used as well. Even a scroll saw or band saw would be beneficial if you have access to it.
  - **Drilling** – A drill with a variety of drill bits is necessary.
  - **Forming** – A foam press will be required to press the material to form around the gun. There are several kinds of presses that can be purchased or made with simple materials. A foam press can simply consist of two pieces of closed cell foam and two pieces of ¾-in. plywood. A vacuum press can even be used for more advanced techniques.
  - **Clamps** – Heavy-duty clamps will be required to hold the press closed (Figure 40). Several small clamps can aid in holding small pieces of plastic.
  - **Heating** – An oven of some sort will be needed.

Figure 40: A few different types of clamps.

- ♦ An infrared thermometer should be used to determine the temperature of the thermoform sheet.

› **Sanding** – A rotary tool with sanding ability can be used. Sandpaper of various grits will be needed for finishing purposes. If you have access to a belt sander or other motorized sanders, they can be used to speed up the process of making a holster.

› **Polish** – A polishing wheel with plastic compound may be used. You can forgo this process with the use of different levels of sandpaper.

- SAFETY GEAR

› **Gloves** – Gloves that can handle high temperatures are a necessity.

› **Eye protection** – Eye protection is necessary to protect eyes from particles.

› **Mask** – A particulate mask will be necessary while sanding and polishing.

› **Ventilation** – Fumes and dust particles can be hazardous to your health.

THERMOPLASTIC SHEET

KYDEX®

Kydex is a line of thermoplastic acrylic-polyvinyl chloride materials manufactured by Sekisui SPI. According to online retailer Heinnie Haynes® (www.heinnie.com):

> *Kydex was originally the masterpiece of Rohm and Haas Company, a Philadelphia-based materials manufacturer working in the aircraft interior business. It was in the late 1960's that people started realizing the possibilities that Kydex offered. They realized that the sheets could be moulded and manipulated into a massive range of shapes by simply heating and moulding around forms. The brand Kydex has since changed ownership a few times, but the brand itself has still managed to become almost a household name for moulded plastics.*
>
> *It has the following advantages:*
>
> - *Waterproof*
> - *Scratch resistant (Rockwell "R" hardness of 90)*
> - *Holds its shape and will not alter unless forced under certain conditions*
> - *Low maintenance*
> - *Able to simply wipe clean*
>
> *Much like any other manufacturing materials, there are different grades of thermoplastic. Kydex manufactures over 40 different lines of thermoplastic sheets, each with its own properties and price point, from budget to premium ranges and everything in between. See the Kydex website for the full details about each sheet variation.*

BOLTARON®

The manufacturer of Boltaron® describes its product as being an ultra-high impact, thermoplastic sheet ideal for gun holsters and knife sheaths.

> *Impact Extreme impact resistance, outstanding physical properties and a wide variety of colors and textures make Boltaron the ultimate alloy material for your most demanding applications.*
>
> *Boltaron sheet is a proprietary, fire retardant, thermoplastic alloy that offers outstanding physical properties, making it the ideal material from which to thermoform and fabricate parts subjected to high impact, abrasion, harsh chemicals and/or temperature extremes.*
>
> *With an Izod impact rating of 20 ft lb./in. (1060 J/m), Boltaron is among the most*

impact-resistant thermoplastic alloys ever produced.

It is also exhibits extreme resistance to heat deformation and cold weather cracking, and is highly resistant to caustic and acidic chemicals spanning the entire pH range, in addition to offering greater abrasion resistance than stainless steel.

Easy to use but difficult to damage, Boltaron eliminates the compromise associated with lesser thermoplastic alloys, FR ABS, and other fire rated thermoplastics, meeting and exceeding the most demanding requirements of formers, fabricators and OEMs alike.

HOLSTEX™

Online retailer and distributor KnifeKits.com has this to say about Holstex:

Holstex™ is a premium grade DIY thermoform PVC based sheet material that is designed for small to medium scale low temperature object molding. Holstex can be used for both vacuum and press molding.

What are the advantages of Holstex over other similar products?

Holstex offers maximum scratch resistance while maintaining low temperature pliability. Scratch resistance increases the aesthetic life of the finished product, increasing overall consumer value and long-range durability.

Holstex is the only thermoform product offered exclusively with dual-side texture. Both sides of Holstex sheet are textured to guarantee that major finished surfaces are visible in 3 dimensions. This significantly increases the value of finished goods, as artist's can control undesired material contrasts on molded goods that are caused by 3D fold-over processes.

Holstex is the only thermoform sheet material that comes exclusively with H-SPM™. H-SPM™ is a (heat-resistant surface protection mask) that protects the texture finish of Holstex prior to and during use. H-SPM™ contains a specially designed self-adhesive layer that can also be used to wrap target objects to protect their finish during the forming application. Once forming is complete, H-SPM™ can be easily removed and discarded, without damage to the object's surfaces. This makes it significantly more valuable in knife and gun holster applications where proper object handling can minimize or eliminate surface scratching or damage during use.

PLANNING

The first step is to plan on what you want to make. You can make either a gun holster or knife sheath. There are infinite possibilities to make with all the different firearms, holster styles, colors, and attachments available.

Here are a few questions you may want to ask yourself first:

- Do you want an inside the waistband holster (IWB) or outside the waistband holster (OWB)?
- Fold-over or pancake holster?
  - There are basically two different types of holsters: fold-over (taco) and pancake. Both types can be worn inside the waistband (IWB) or outside the waistband (OWB), based on what belt attachments are used. The fold-over holster is one piece of material that is folded over the firearm, like the name describes. The pancake holster is two pieces of material stacked on top of each other with the firearm that is placed between them.
- For which firearm/knife?
- Left- or right-handed?
- What color holster do you want?
- Which belt attachment?
  - Belt loops (rubber/nylon or leather)
  - Belt clip
  - Paddle mount
  - Injection molded belt loop
- Will there be a cant in the firearm?

A "cant" is the angle that the gun is tilted in the holster (Figure 41). Some of the most common cants are 0˚, 10˚, 15˚, 20˚, or 25˚. A "straight-drop" holster has 0˚ of cant and the gun rides vertically. An "FBI cant" holster has a cant of between 10˚ and 20˚ but is typically found to be around 15˚. For smaller to mid-size guns, 0˚ and 10˚ cants work great for the 3 o'clock position while wearing. For mid- to full-size guns, 15˚ or 20˚ cants work for the 4 – 5 o'clock position. Some holsters are even canted to 30˚ or more. For those who prefer to carry a full-size gun, the 25˚ or more cant works for the 5 – 6 o'clock position. This is all based on preferences.

Once you gather all the important information about what kind of holster you will be making, it's time to start planning how you will go about achieving what you want your final product to look like. If this is your first time making a holster, it is wise to trace the gun on a piece of paper and make a rough sketch of what you want to make. This is where you can plan on where you will place your belt attachments, screws/eyelet, or cut lines.

Figure 41: Different types of cants. Image courtesy of ingunowners.com.

Mold Preparation

This is the critical step to thermoforming. It is preparing the mold to be formed. If you look at the item you are going to mold around, there may be crevices, indentions, or items that may catch when you are attempting to remove the firearm from its holster. The most common items are the safety, ejection port (Figure 42), screws/pins, and sights.

STEP 1 - FITTING

You will need the firearm or an actual size replica of the firearm. Be aware that the molding process will involve heat and extreme pressure. **Note**: If you are using the actual firearm and it is made of polymer, place an empty magazine inside the firearm. This will prevent the grip from warping inward. If you choose to use a replica, be aware that all replicas are not made to the correct size of the actual firearm; this may cause issues with proper fit of the firearm. Thoroughly clean the firearm that you are using so that the tape will adhere to it. Use a degreaser or gun cleaner.

Figure 42: The ejection port of a real firearm will need to be built up.

Figure 43: One of the high spots on a pistol is the slide lock.

STEP 2 - BUILD-UP

You will need several items to build up the firearm in areas that will allow for fasteners and for the firearm to move freely in the holster. Take a good look at the firearm that you will be working with. Any high (Figure 43) or low spots on the gun may be areas that could possibly catch while holstering or unholstering. Place blocking on these key locations that require it. Some of the areas to consider are the ejection port, safety, sights, slide locks and any extended pins.

Figure 44: Here are a few pieces that will be used for blocking.

Figure 45: Sight channel added on top and wood filler in the trigger guard was added.

You will need a blocking material, such as wood or plastic (Figure 44). Items like pencils, dowel rods, paint stirrers and craft sticks can be used for blocking. For example, cut a small piece of wood or plastic to fill in for the ejection port. As well, place a piece of wood or plastic for a channel that the slide stop can move through. Make sure that you construct a sight channel using something similar to a dowel or pencil.

Figure 46: Blocking for belt attachment shown above. Retention for fold-over holster on bottom.

Figure 47: Top: Replicate that was made with all the blocking already attached. Bottom: Training pistol that had modeling clay added and hardened for blocking purposes.

Figure 48: Finished product for pancake holster.

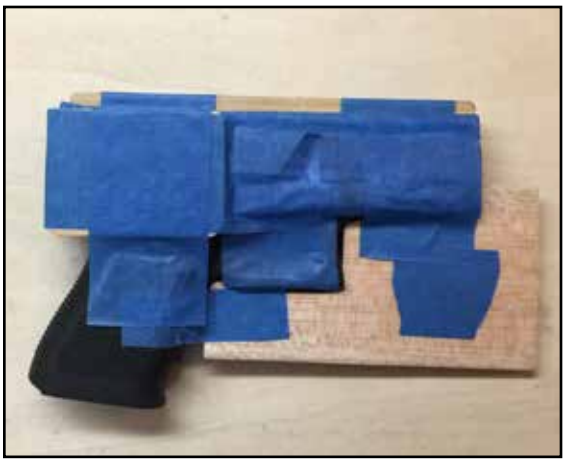


Figure 49: Finished product for fold-over holster.

The most important piece to place is inside the trigger guard (Figure 45). This is where your retention will be formed. Also, it is a safety issue. You do not want a large indention inside the trigger guard, which may put pressure on the trigger, causing it to fire inside the holster. Additionally, retention points can be placed on the gun (Figure 46). To attach blocking, use a non-residue tape, such as a blue painter's tape. There are firearm molds that are made specifically for holster making that have the blocking already attached (Figure 47).

STEP 3 - FORMING

Add a few layers of tape along the slide to give a standoff for the thermoformed material (Figure 48). **Note**: It will shrink while cooling.

Once this is finished, it may look like a big pile of tape in the shape of a gun or knife (Figure 49). Now you are ready to start forming.

Now is the time to start gathering all the materials that you will need to start this holster (Figure 50). You will need to get a piece of

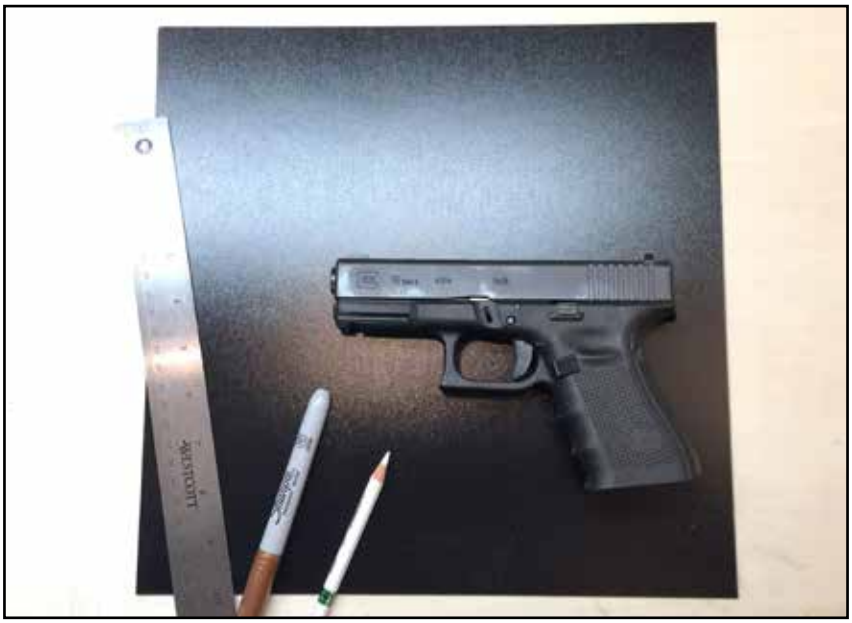
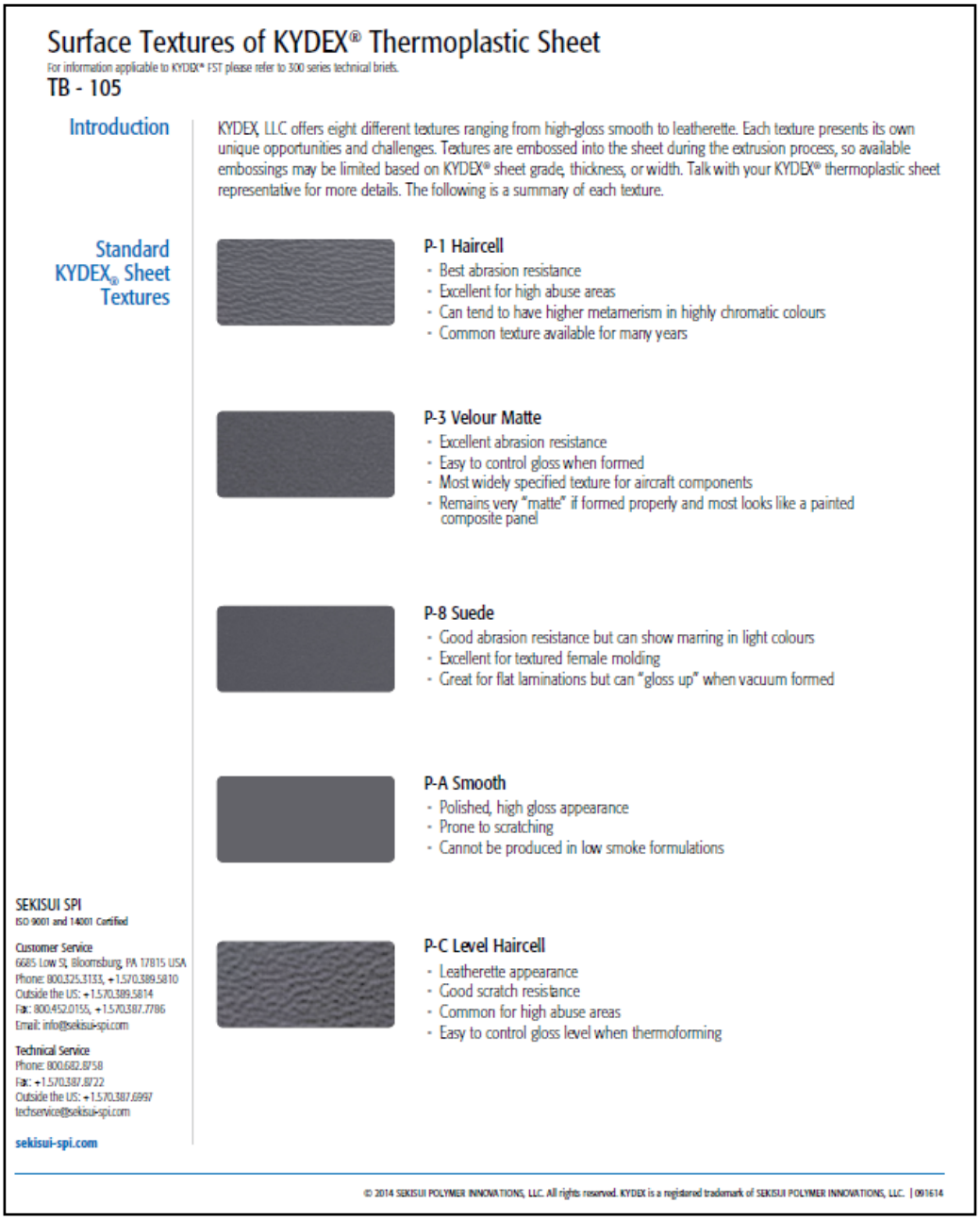


Figure 50: Time to start marking cut lines.

material that you intend on using. Make sure that you have a size big enough to fully cover the gun that you are using. Keep in mind that shrinkage may occur. If you are making a taco holster, the material has to fully cover both sides with one piece of material. If you are making a pancake holster, then you will need two pieces of material to sandwich the gun. Make sure there is plenty of material above and below the gun for fasteners to be used.

MATERIAL TEXTURE

The thermoplastic that you will be using does come in various types of textures. If you look at the material, there are two sides. One side has a textured side and the other side is smooth. The side with the texture is the outside, which is the side that you want facing outside of the holster. You will always want to keep the smooth surface



Surface Textures of KYDEX® Thermoplastic Sheet

For information applicable to KYDEX® FST please refer to 300 series technical briefs.

TB - 105

Introduction

KYDEX, LLC offers eight different textures ranging from high-gloss smooth to leatherette. Each texture presents its own unique opportunities and challenges. Textures are embossed into the sheet during the extrusion process, so available embossings may be limited based on KYDEX® sheet grade, thickness, or width. Talk with your KYDEX® thermoplastic sheet representative for more details. The following is a summary of each texture.

Standard KYDEX® Sheet Textures

P-1 Haircell
- Best abrasion resistance
- Excellent for high abuse areas
- Can tend to have higher metamerism in highly chromatic colours
- Common texture available for many years

P-3 Velour Matte
- Excellent abrasion resistance
- Easy to control gloss when formed
- Most widely specified texture for aircraft components
- Remains very "matte" if formed properly and most looks like a painted composite panel

P-8 Suede
- Good abrasion resistance but can show marring in light colours
- Excellent for textured female molding
- Great for flat laminations but can "gloss up" when vacuum formed

P-A Smooth
- Polished, high gloss appearance
- Prone to scratching
- Cannot be produced in low smoke formulations

P-C Level Haircell
- Leatherette appearance
- Good scratch resistance
- Common for high abuse areas
- Easy to control gloss level when thermoforming

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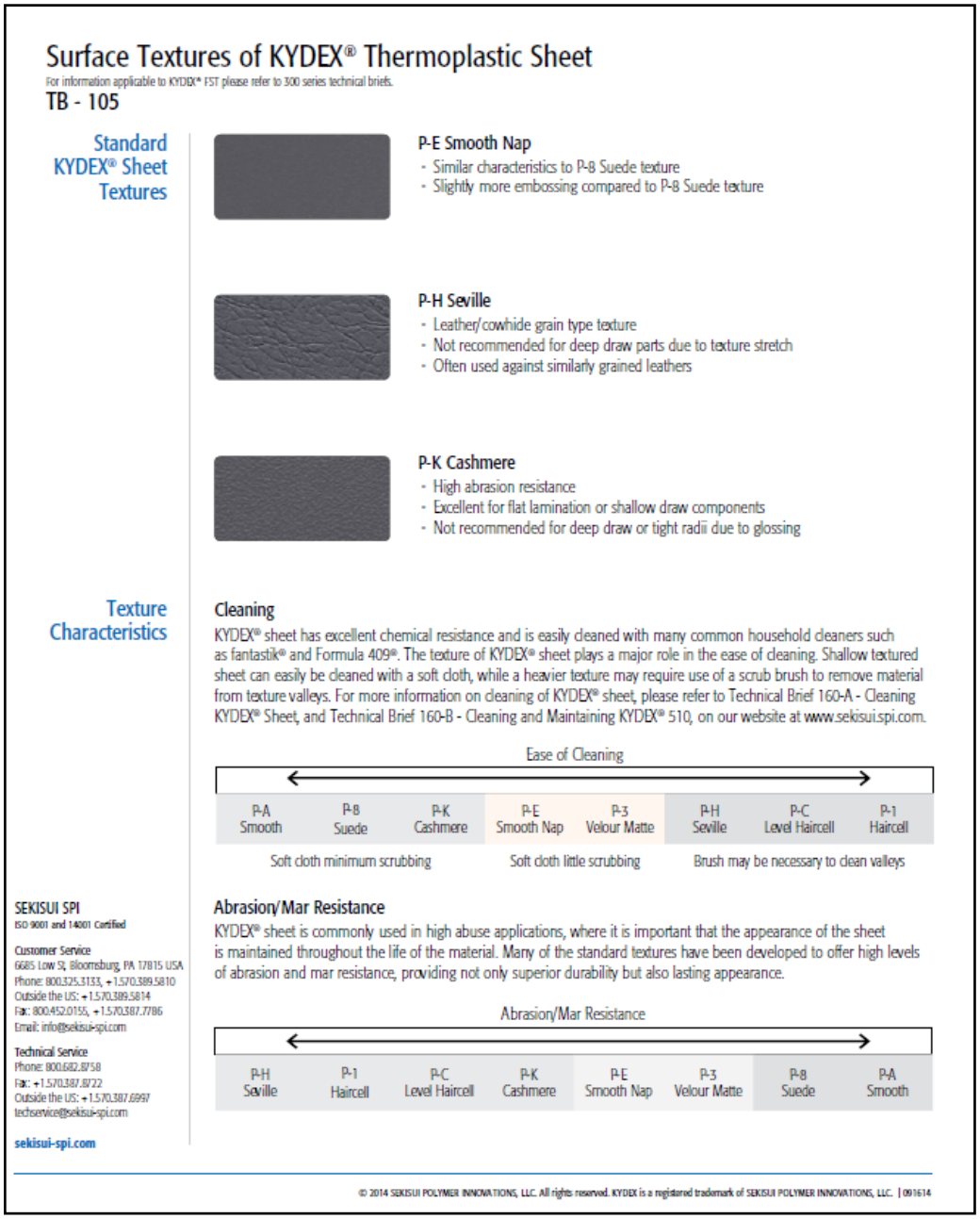
Figure 51: Surface textures of Kydex.

next to your firearm or knife to prevent unwanted rubbing or scratching (Figures 51 and 52).

First, mark the smooth side of the sheet with a straight edge (Figures 53 and 54) and pencil or marker. To cut the material, several items can be used. You can use anything from a razor blade to score-and-snap (Figure 55) to a bandsaw or scroll saw to cut sheets of material.

MATERIAL HEATING

There are several ways to heat the thermoform material. The basic way is to use an oven of some sort. You can use a regular kitchen oven to get to the temperature you will need. Make sure you first ask permission of others in the vicinity, as an overbearing smell may be caused by the plastic and may linger for a while. Most holster



Surface Textures of KYDEX® Thermoplastic Sheet

For information applicable to KYDEX® FST please refer to 300 series technical briefs.

TB - 105

Standard KYDEX® Sheet Textures

P-E Smooth Nap
- Similar characteristics to P-8 Suede texture
- Slightly more embossing compared to P-8 Suede texture

P-H Seville
- Leather/cowhide grain type texture
- Not recommended for deep draw parts due to texture stretch
- Often used against similarly grained leathers

P-K Cashmere
- High abrasion resistance
- Excellent for flat lamination or shallow draw components
- Not recommended for deep draw or tight radii due to glossing

Texture Characteristics

Cleaning

KYDEX® sheet has excellent chemical resistance and is easily cleaned with many common household cleaners such as fantastik® and Formula 409®. The texture of KYDEX® sheet plays a major role in the ease of cleaning. Shallow textured sheet can easily be cleaned with a soft cloth, while a heavier texture may require use of a scrub brush to remove material from texture valleys. For more information on cleaning of KYDEX® sheet, please refer to Technical Brief 160-A - Cleaning KYDEX® Sheet, and Technical Brief 160-B - Cleaning and Maintaining KYDEX® 510, on our website at www.sekisui.spi.com.

Ease of Cleaning

P-A Smooth	P-8 Suede	P-K Cashmere	P-E Smooth Nap	P-3 Velour Matte	P-H Seville	P-C Level Haircell	P-1 Haircell
Soft cloth minimum scrubbing			Soft cloth little scrubbing		Brush may be necessary to clean valleys		

Abrasion/Mar Resistance

KYDEX® sheet is commonly used in high abuse applications, where it is important that the appearance of the sheet is maintained throughout the life of the material. Many of the standard textures have been developed to offer high levels of abrasion and mar resistance, providing not only superior durability but also lasting appearance.

Abrasion/Mar Resistance

P-H Seville	P-1 Haircell	P-C Level Haircell	P-K Cashmere	P-E Smooth Nap	P-3 Velour Matte	P-8 Suede	P-A Smooth

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Figure 52: Surface textures of Kydex, continued.

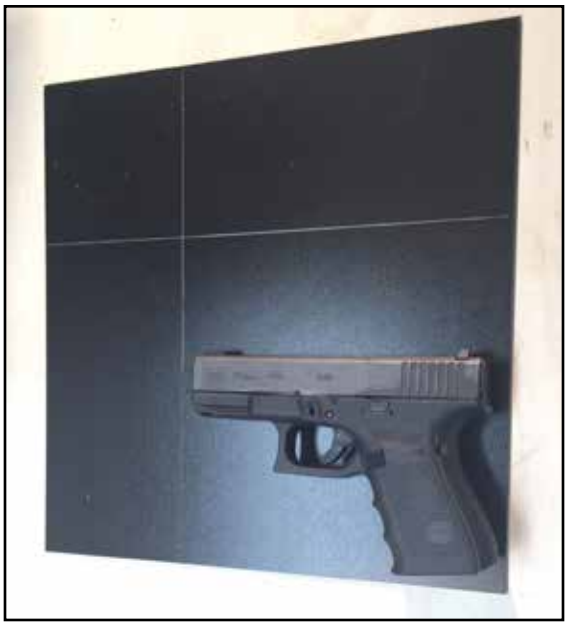


Figure 53: Here it is planed out. 8 in. x 8 in. square for a fold-over holster.

Figure 54: Use a straight edge to help with cutting.

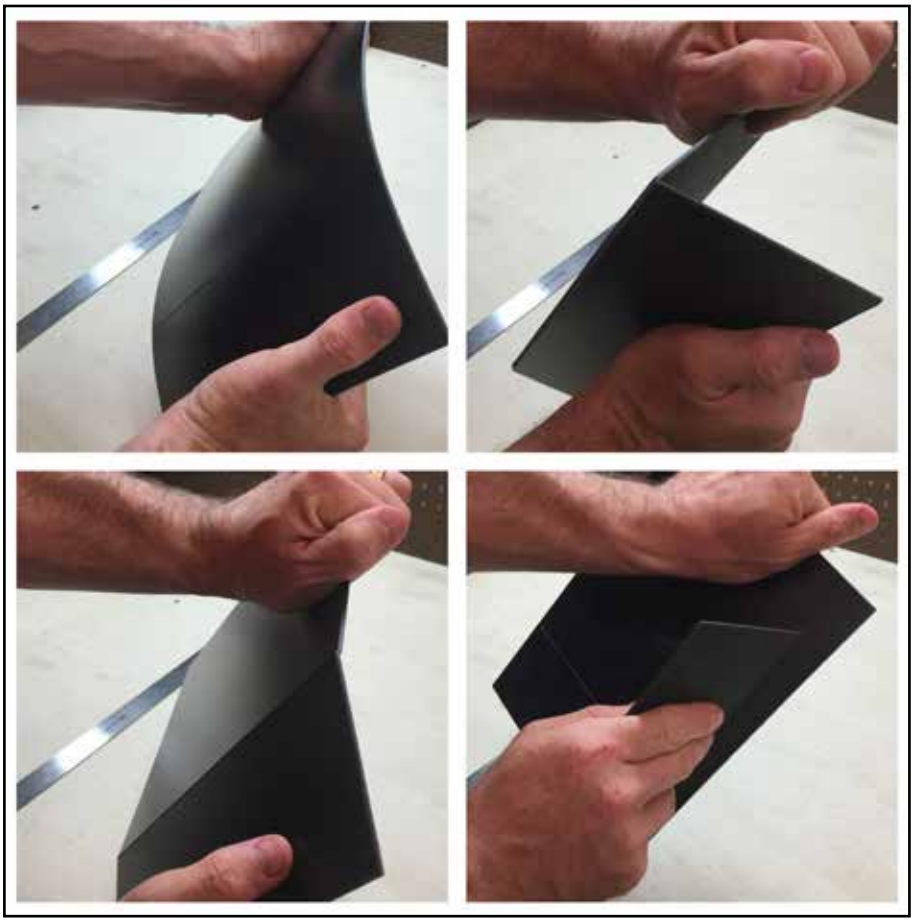


Figure 55: Score and snap the sheet.

Figure 56: Material cut for a fold-over holster.

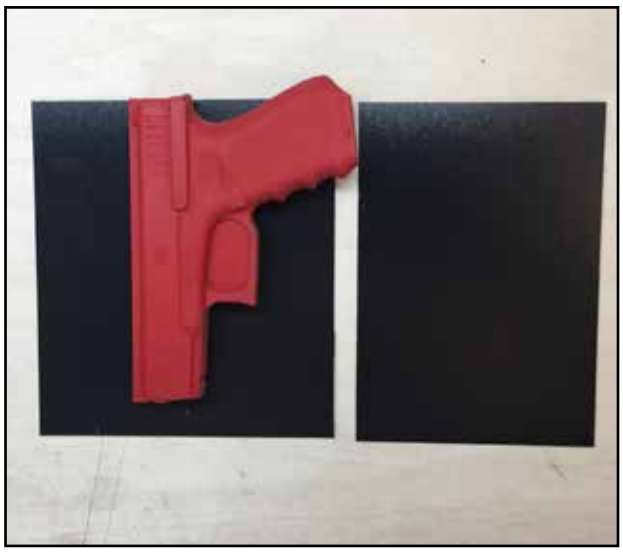


Figure 57: Materials cut for a pancake holster.

Figure 58: Toaster oven, metal pan, parchment paper, gloves, and infrared thermometer seen here.

makers have used a small toaster oven (Figure 58). This is preferred because it is cheaper and smaller in size so it can be located closer to the work area, and is faster to heat up due to smaller interior space.

The best way to heat material is by using a t-shirt heat press. This has a thermostat that you can set to your desired temperature, and it gives a uniformed heat surface. Using the heat press also minimizes material shrinkage.

Place your material (texture side up) on top of a cookie sheet or something similar. To prevent the material from sticking to the cookie sheet, place a Teflon™ sheet or parchment paper between the two. Do not place the material too close to the heat source in order to keep it from melting or burning. Slowly heat the material until the desired heat has been established. You can check the temperature by using an infrared thermometer. Do not heat too fast so as to prevent shrinkage. When the desired temperature

Figure 59: Picture of temperature while checking.

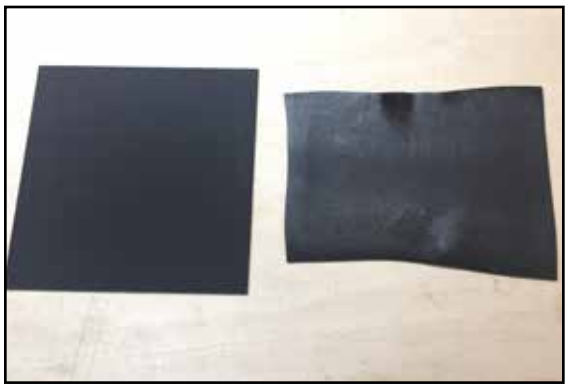


Figure 60: Two pieces of the same size. Right piece was heated too quickly.

(Figure 59) has been reached, carefully remove the material from the oven. ***Make sure to use gloves to keep from burning your hands.***

As you can see in Figure 60, the two pieces started off the same size. The piece on the right was heated too quickly and caused extreme shrinkage. Figure 61 shows that the shiny spots on the top and bottom are caused by uneven heating. The sign of overheating is displayed by shininess.

TEMPERATURE & TIME

There are many factors that can influence what temperature is required for forming: material thickness, composite, or color. According to Kydex, the best temperature for forming is 350˚ – 380˚ F. Refer to Figures 62 and 63. The melting point is approximate 400˚ F.

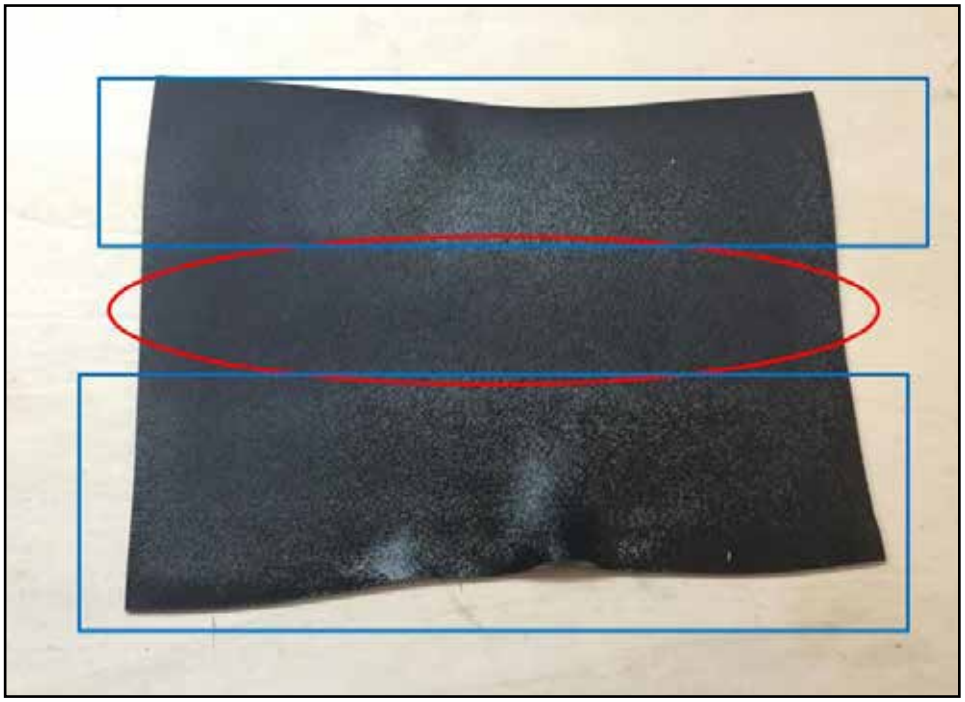
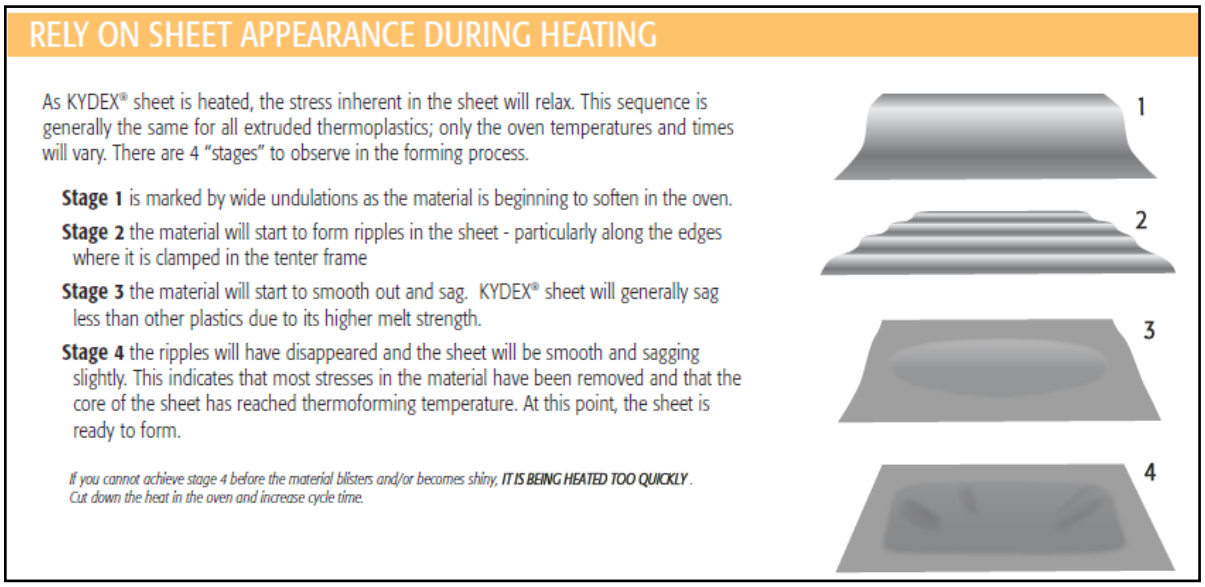


Figure 61: Spots on the top and bottom are due to overheating.

Just like the temperature, the amount of time to heat the material can depend on thickness and composite. The thinner material, such as the .060 in., does not take as long to heat as the thicker .125 in. The key to properly heating the material is to go slow and slowly increase the temperature to minimize shrinkage.



RELY ON SHEET APPEARANCE DURING HEATING

As KYDEX® sheet is heated, the stress inherent in the sheet will relax. This sequence is generally the same for all extruded thermoplastics; only the oven temperatures and times will vary. There are 4 "stages" to observe in the forming process.

Stage 1 is marked by wide undulations as the material is beginning to soften in the oven.

Stage 2 the material will start to form ripples in the sheet - particularly along the edges where it is clamped in the tenter frame

Stage 3 the material will start to smooth out and sag. KYDEX® sheet will generally sag less than other plastics due to its higher melt strength.

Stage 4 the ripples will have disappeared and the sheet will be smooth and sagging slightly. This indicates that most stresses in the material have been removed and that the core of the sheet has reached thermoforming temperature. At this point, the sheet is ready to form.

If you cannot achieve stage 4 before the material blisters and/or becomes shiny, ***IT IS BEING HEATED TOO QUICKLY****. Cut down the heat in the oven and increase cycle time.*

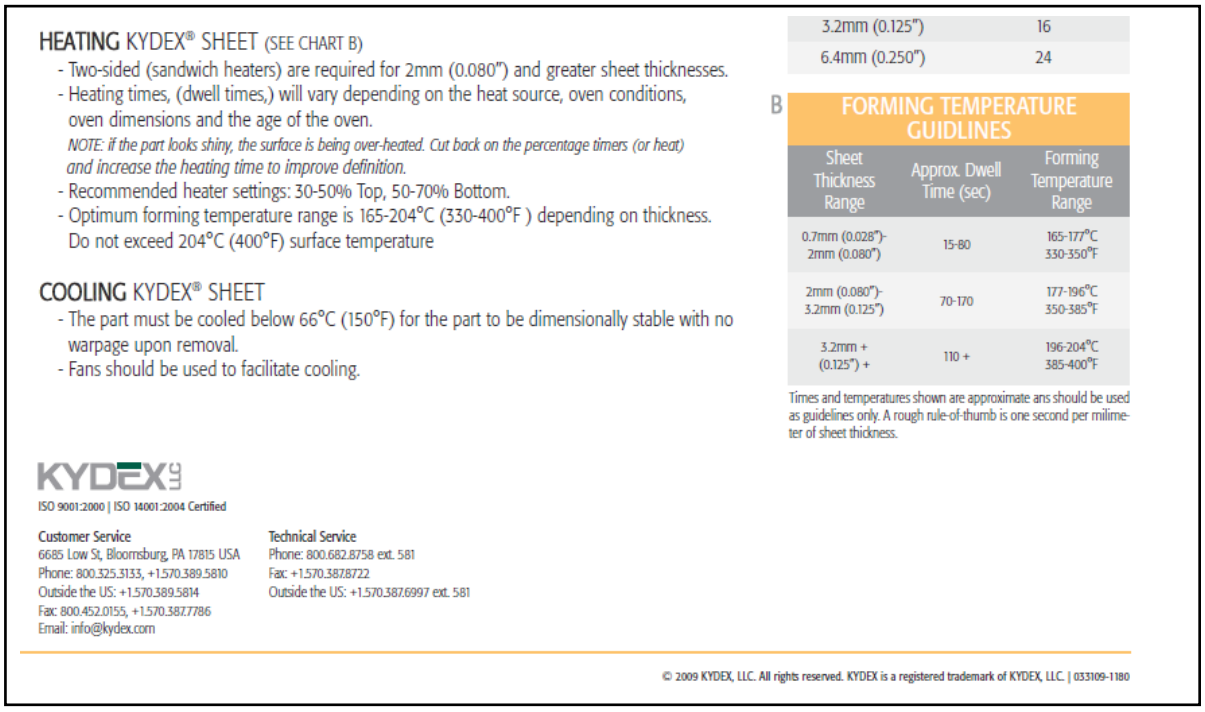
1

2

3

4

Figure 62: Four stages of appearance during heating KYDEX.



HEATING KYDEX® SHEET (SEE CHART B)

- Two-sided (sandwich heaters) are required for 2mm (0.080") and greater sheet thicknesses.
- Heating times, (dwell times,) will vary depending on the heat source, oven conditions, oven dimensions and the age of the oven.
  NOTE: if the part looks shiny, the surface is being over-heated. Cut back on the percentage timers (or heat) and increase the heating time to improve definition.
- Recommended heater settings: 30-50% Top, 50-70% Bottom.
- Optimum forming temperature range is 165-204°C (330-400°F) depending on thickness. Do not exceed 204°C (400°F) surface temperature

COOLING KYDEX® SHEET

- The part must be cooled below 66°C (150°F) for the part to be dimensionally stable with no warpage upon removal.
- Fans should be used to facilitate cooling.

3.2mm (0.125")	16
6.4mm (0.250")	24

B

FORMING TEMPERATURE GUIDLINES

Sheet Thickness Range	Approx. Dwell Time (sec)	Forming Temperature Range
0.7mm (0.028")-2mm (0.080")	15-80	165-177°C 330-350°F
2mm (0.080")-3.2mm (0.125")	70-170	177-196°C 350-385°F
3.2mm + (0.125") +	110 +	196-204°C 385-400°F

Times and temperatures shown are approximate ans should be used as guidelines only. A rough rule-of-thumb is one second per milimeter of sheet thickness.

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Figure 63: Recommended time and temperature of heating KYDEX.

Figure 64: Hold the material on the firearm firmly.

Figure 65: Close the lid.

Figure 66: Clamp mold close.

Molding

Once the material is heated to the proper temperature, remove it from the heat source, making sure to use gloves so that you do not burn yourself. You will have very little time to work this material before it starts to harden.

TACO HOLSTER

Place your hot material in your press. If doing a taco holster, fold the material in half and place your firearm in the center of the material. Make sure there is ample material to fully cover both sides of the firearm (Figure 64). While still holding the material, make sure that the firearm and material do not shift, and then close the press and place clamps to keep it closed (Figure 66). Place enough pressure to make sure that the foam fully conforms around the firearm. However, do not put excessive pressure, which will cause the press or firearm that is inside the press to break.

PANCAKE HOLSTER

If making a pancake holster, place one piece of material in the press lying face down. Then, place the gun on the material, followed by the second piece of material on top facing upward. While holding all the items so that they will not shift, close the press and place clamps to keep it closed. Place enough pressure to make sure that the foam fully conforms around the firearm. However, do not put excessive pressure, which will cause the press or firearm that is inside the press to break.

Note: If you choose, you can do one side at a time; however, this will take twice as long to mold.

COOL DOWN

Give the material time to cool. The times may vary due to several factors: the original temperature of material before placing in the press, the type and thickness of foam that was used, or even the temperature of the work space that you are using. Give approximately 30 minutes of time for cooling; make sure that it is hard and

Figure 67: Example of what a formed shell for a fold-over holster will look like when removed from the press.

Figure 68: Example of what formed shells for a pancake holster will look like when removed from the press.

Figure 69: Example of what formed shells for a pancake holster will look like when removed from the press.

formed. If it is still hot, it will be soft and moldable. When you are satisfied with the time and hardness of the shell, remove it from the press. Be careful of the clamps and press because of extreme pressure they are under.

Once removed from the press, you will have a formed holster shell (Figures 67, 68 and 69) that needs to be trimmed and finished. This is where you can determine to go further or remold. If you are not happy with the formed shell, you can slowly reheat the material again and place it back into the press. **However, be aware that reheating the material for the second time will cause even more shrinkage.**

TROUBLESHOOTING GUIDE

NOTE: Most often the problem is one of trying to heat KYDEX® sheet too quickly.
See reverse side for heating times and see above for how the sheet should look during forming.

PROBLEM	PROBABLE CAUSE	PROBABLE SOLUTION
POOR PART DEFINITION	- Heating too quickly - not getting core of sheet to proper forming temp - Uneven heating of sheet - Insufficient heating - Poor or insufficient vacuum	- Cut back on heat and increase heating time to compensate if needed. - Replace old or worn heaters - use screening if necessary to even-out heat distribution. - Increase heating time . - Check vacuum lines. Increase vacuum holes. Check seals.
GLOSSY OR SHINY SPOTS	- Heating too quickly or over-heating - Uneven heating of sheet	- Cut back on heat and increase heating time to compensate if needed, - Replace old or worn heaters - use screening if necessary to even-out heat distribution.
WARPAGE IN PART	- Removing part too soon - Sheet core too cold during forming	- Increase cooling time on mold or use cooling fixture. - Cut back on heat and increase heating time to compensate if needed.
EXCESSIVE WALL THINNING	- Sheet too cold during forming - Sheet gauge too thin - Improper forming method	- Increase heating time. - Increase sheet gauge - Try Billow-snap back (male) or billow-plug assist (female).

Figure 70: KYDEX troubleshooting guide.

Finishing

CUT & DRILL

With a pencil or marker, start marking a rough outline of where you want to cut and drill holes (Figures 71 and 72). Once that has been established, you can start cutting away the extra material. If you're happy with what you have drawn, remove the firearm from the molded plastic. This will leave you with a shell. To cut, use the same tools that you used earlier or use a rotary tool with cutting wheel. When cutting, take safety in mind. Wear proper eye protection and a facemask because plastic particles will be flying (Figure 75). If you have access to any other electric saws, such as a bandsaw or scroll saw, they can be used to speed up the process. If you are happy with the overall shape of the holster, it is time to start sanding.

For any fasteners or attachments that you will need, drill holes in the holster with a hand drill or drill press. If you are drilling eyelets, use a ¼ in. drill bit for #8 eyelets (Figure 86). If you are using #6 eyelets, use a ⅜ in. drill bit. If you are using Chicago Screws or posts, use the proper drill bit that is appropriate for that fastener. The 7⁄32 in. drill bit can accommodate most screws and posts.

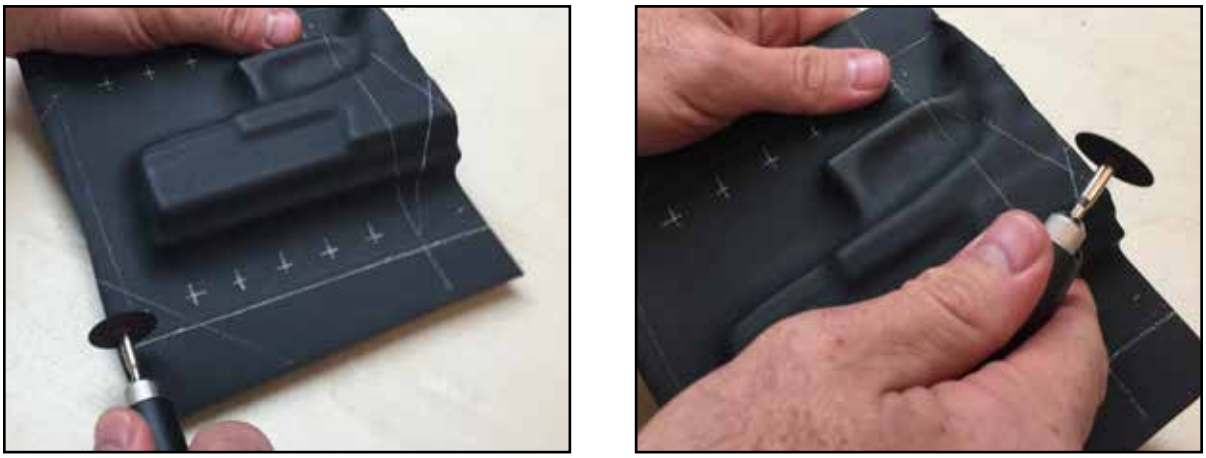
Figure 73: Pancake holster marked for cutting and drilling.

Figures 71 & 72: Fold-over marked with cut lines. Notice the + marks. That is where the holes will be drilled for the fasteners.

Figure 74: Moto tool with attachments provided by SDI.

Figure 75: Examples of protective equipment.

Figures 76, 77 & 78: Cutting the extra material off of the fold-over holster.



Figures 79 & 80: Cutting the extra material off the pancake holster.

Figure 81: Finished cutting of the front of the pancake holster.

Figure 82: Use the front piece to make cut lines on the back piece of the pancake holster.

Figures 83 & 84: Drilling 7/32 in. holes for belt attachments.

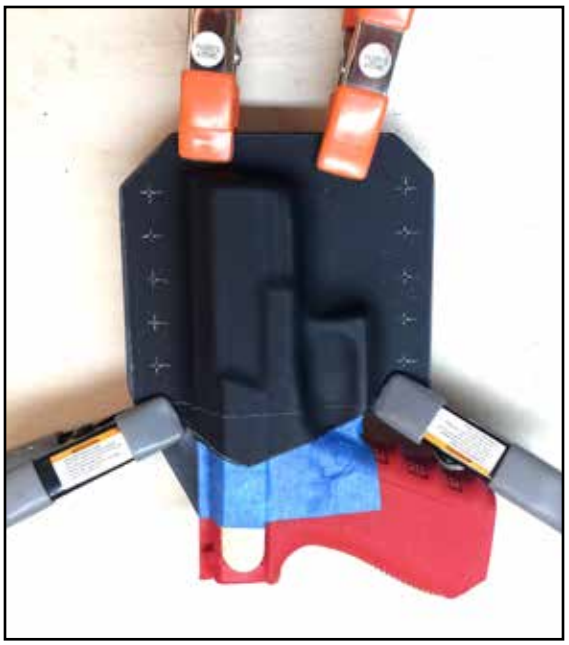


Figure 85: Use clamps to keep both pieces of the pancake holster together while drilling.

Figure 86: Use a ¼ in. drill bit for eyelet holes.

Figure 87: A sanding drum is used to sand the edges.

Figure 88: You can even use a block sander to sand flat edges.

SAND & POLISH

Sand the holster using a sanding drum (Figure 87) on your rotary tool or a block sander. Sand to remove the extra material that was left during the cutting portion of the holster. Use a lower grit sandpaper to do a rough sand and then work your way up to a higher grit to get closer to a finished edge. If you like the matte finish that the sanding has left, then there is no need to polish the edges.

Double-check the fit and feel of your holster by placing the firearm inside to make sure there is no extra material that needs to be sanded away. If more material needs to be removed, this is the time to do it. Also, you can use a heat gun to soften any areas that need to be remolded.

If you care to take the time and effort to polish, then you will need to place a polishing wheel on your rotary tool. The same safety gear worn earlier while cutting should be worn once again. Run the wheel through some plastic polish compound. Once the wheel has been evenly coated with compound, go back over the edges with this wheel. If done correctly, this will leave a mirror-like shine to the edges of the material (Figure 89).

Figure 89: Different edges going from left to right: Cut with saw. Rough sanding. Sanded with progressive finer grit sandpaper (matte finish). Polished with polishing compound (shiny).

Figure 90: Items needed for polishing. Polishing wheel and some type of plastic polish compound.

Figure 91: Polishing the edges of the holster.

Figure 92: Items needed to attach eyelets.

FINISHING

With all the cutting, sanding, and polishing that was done, an ample amount of plastic particles and polishing compound will be present. Use a stiff bristle brush, hot water and soap, or a cleaner, such as Simple Green®, to remove any leftover particles or polishing compound left on the holster. Wipe off any water and let it dry before moving to the next process.

Once it is dry and clean, it is time to install all needed hardware.

With a clean shell, start to attach the belt attachments and fasteners to make this a complete holster. First, if you are using eyelets to join two pieces of material together, this is the time to do it. You will need a hammer, the hand flaring set that came in your kit, and several #8-9 black fastening eyelets to accomplish this task. Place the eyelet through the predrilled ¼ in. hole in your holster with the flared end upward. Then, place this part on top of the base of the eyelet die (Figure 93). With an eyelet flaring tool, place it on the opposite end of the eyelet. Using a hammer, tap the punch until it rolls the bottom onto the material. Do this step for every eyelet that you intend on using.

Figure 93: Before hammering, place the eyelet flaring tool on the eyelet as shown.

Figure 94: Example of how it looks while installing an eyelet.

Figure 95: How the final process looks.

Figure 96: Holster with belt clip and fasteners attached.

Figure 97: Holster with belt loops.

Figures 98 & 99: Belt loop and attachments. Order of installation: binding post, holster, rubber washer, belt loop, button fastener, screw.

If you are not using eyelets, use a screw and binding post, such as a Chicago Screw. Install all belt attachments and screws that are needed to finish your holsters. **Do not over-tighten any screws for risk of cracking the material or fastener**. It is highly recommended to use a type of thread locker on screws to prevent them from loosing.

With all the belt attachments and fasteners installed, you will have a finished holster.

Figure 100: Completed holster with belt loops.

Figures 101 & 102: Examples of different kinds of belt loops that can be purchased for OWB holsters.

APPENDIX

MAKE A MOLDING PRESS

This is as simple as getting two pieces of ¾-in. x 12-in. x 12-in. plywood and two pieces of medium density foam of the same size, along with several clamps to hold everything together.

The materials are pretty simple for this Kydex press. The writer of this lab used scraps found in his workshop:

- ¾-in. plywood
- 2-in. x 4-in. board
- Clamps
- 2 heavy-duty door hinges
- Deck screws
- Nuts and bolts

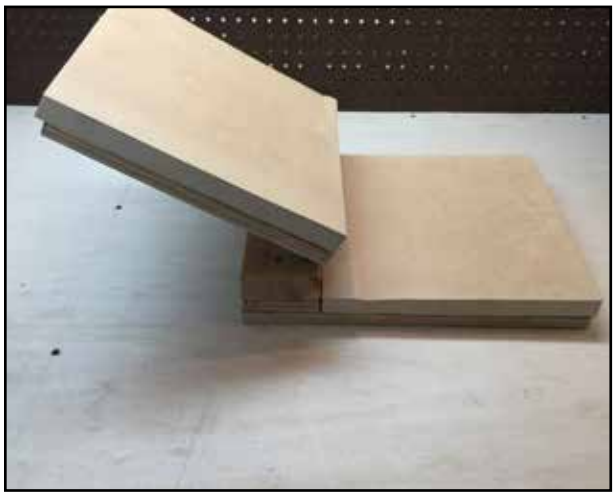
The top is 12-in. x 12-in. The bottom plate is 16-in. x12-in.. One piece of 2-in. x 4-in. was cut to 12 in. and one piece of ¾-in. plywood was cut to match the 2-in. x 4-in. They are stacked (screwed and glued) for the hinge mount.

Glue and screw the pieces to the bottom plate.

Figure 1: CKK molding press from Knifekits.com.

Give the hinge just a little room to swivel freely by spacing just ⅛ in. away from the hinge and the 2-in. x 4-in. Mount the hinge to the top plate first. Use the nuts and bolts. Then, screw the hinges to the 2-in. x 4-in.

Two pieces of 1 in. thick neoprene are being used for the mold foam.



Figures 2 & 3: Different views of a homemade book press.

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